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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61K 9/127, 9/107, 9/06

A1

(11) International Publication Number: WO 94/03157

(43) International Publication Date: 17 February 1994 (17.02.94)

(21) International Application Number: PCT/EP93/01965

(22) International Filing Date: 23 July 1993 (23.07.93)

(30) Priority data:
M192A001831 28 July 1992 (28.07.92) IT

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(81) Designated States: CA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PHARMACEUTICAL COMPOSITIONS FOR TRANSMUCOSAL DELIVERY OF PEPTIDES

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PHARMACEUTICAL COMPOSITIONS FOR TRANSMUCOSAL DELIVERY OF PEPTIDES.

The present invention refers to pharmaceutical compositions in the form of microemulsions or liposomic dispersions for the transmucousal administration of proteins or peptidic substances pharmacologically active; they differ from the known liposomic or microemulsified compositions in that they contain in addition a thermosetting agent able to enhance the residence time on the administration site and, consequently, to promote the absorption of the delivered drug.

The administration of proteinic substances has been, from few years ago, limited to the parenteral route as it was the only one which granted a good absorption to molecules having a complex structure and not able to tolerate environments with a high acidity and rich of proteolytic enzymes such as that ones can be found in the digestive apparatus. The need to apply by means of an invasive way, the difficulty in obtaining, on a large scale, many proteins from natural sources and the very high activity of such substances, with the consequent risks of overdosage, have determined the limited diffusion of such substances in

results in absorption or reproduciblity of the same: the transit time variability in the digestive apparatus, associated to the large presence of proteolytic enzymes, has made the researcher to consider the oral administration as a problem.

More recently, always in the attempt to avoid the more invasive parenteral administration, formulations suitable to the nasal administration of proteinic substances have been proposed.

The tipical disadvantage of this way of administration consists in: the relatively reduced area available for the absorption, the high clearance (which reduce the time of contact) and the particular characteristic of the muconasal epithelium which covers the upper respiratory organs, that is the presence of cilia in association with mucus producing glands.

In addition, the "absorption promoters" frequently used in formulations for nasal administration produce a relevant damage to the mucociliary clearance of the deposit zone of the formulation and give problems to the repeated or chronic treatment cycles.

With the same aims,it has also been proposed the rectal administration of protein substances: this kind of administration is nevertheless confined in the mediterranean area and even considered unproposable to the nordamerican and nordeuropean populations. In addition to the ethnical inconvenient, is to be considered that the rectal ampoul has a limited surface and a basic pH.

More recently it has been found that the intravaginal way, till now considered for local

treatment only, can be used to allow the systemic absorption of protein substances. The vaginal mucous is in fact able to allow the diffusion of substances pharmacologically active from the application surface to the dermic stratum where is present a rich vascular area able to absorb and drain in the systemic circle, besides the deep dermic stratum, considerable quantity of the substance applied.

An important characteristic wich allow high absorption values in the vaginal area, as well as for nasal cavity and mucous in general, is the bioadhesion of the formulation.

The formulations commonly used in the medical practice take advantage of the vehicle charachteristics: its viscosity and composition play an important role on the time of persistence of the drug effective amount in the absorption area, as well as the achievement of an opportune absorption area and the extension of the same.

Generally, the lower is the mobility of the vehicle, the higher is its viscosity then, the more permanence time increases, consequently, higher is the possibility that active substance is quantitatively absorbed.

Nevertheless, we must not neglect the fact that, usually, a reduced viscosity helps to spread the dispersion of the dosage applied by means of suitable mechanical devices, such as the nasal minipump or foam generators, allowing a very fine distribution of the product. This is very important to increase the contact surface and promote drug absorption.

The objects of present invention are pharmaceutical compositions in the form of microemulsions or liposomic dispersions characterized by the fact that contain a thermosetting agent able to allow the product viscosity increase with temperature, thus allowing a longer mucousal residence time and enhanced drug absorption profile.

Due to the thermosetting properties of the vehicles it is possible to make pharmaceutical compositions which have a reduced viscosity at room temperature, helping the distribution on a larger surface, with a product finely divided. When the composition reach the mucous a structural change take place as a function of the body temperature, the viscosity of the product increase thus determining a large persistence of the system on the absorption zone.

The use of formulations that are liquid at room temperature but which increase their viscosity with temperature giving semi-solid products when warmed to the body value is already known.

There are, in fact, some patents that describe the use of a particular polymer (Pluronic) to reach that goal.

As example, the U.S. Pat. No. 4,478,822 describes a vehicle useful to deliver a medicament to a body orifice, with a drug delivery system consisting of a clear liquid which forms semi-solid gel at human body temperature.

The desired sol-gel transition temperature of the solution can be modified by changes in polymer concentration or in chemical characteristics of the

solution.

We have surprisingly found that the same goal can be obtained also in systems more and more complex, like liposomes of microemulsions.

Normally, this type of formulations require an hard work to balance the composition. In fact, microemulsions are a very complex system with the coexistence of at least three different phases: a disperse phase, an interface layer of surfactants and/or cosurfactants surrounding the disperse phase, a continuous phase that contains the previous ones. The addition of relevant amounts of copolymer in order to obtain the sol-gel system transition, normally change dramatically the precise ratio between the 4 main components of the microemulsion system, that are water, surfactants, cosurfactants and oil. Only a formulation work devoted to find a new balance point allows to obtain thermosetting microemulsions. The same problem, with due proportions and limitations, is arising also to liposomic dispersion.

In a typical realization, the invention uses as thermosetting vehicle, a polyoxyethylene-polyoxypropylene copolymer, preferably the one known with the trade name of Pluronic F 127™ or Lutrol F 127™. These characteristics, which are favourable even when present in conventional solutions, are particularly important

phospholipidic material which are alternated to discrete and isolated aqueous spaces.

The high affinity with mucouses, typical of liposomic systems, is dramatically increased by the introduction of termosetting polymers, generating a product with bioadhesive characteristics which, by increasing the potential of vectorisation, leads to an improved activity.

For the liposomic products, that contain the polyoxyethylene-polyoxypropylene copolymer, the viscosity changement induced by the temperature is reversible (fig. 1).

What previously said can be extended to the microemulsionated systems too: the well proportioned combination of its constituent, essential from a structural point of view, with a polyoxyethylene-polyoxypropylene copolymer produces an "apparent solution" able to increase the viscosity when in contact with mucouses. The human body application of this system, following the partial solvent evaporation, generates a barrier which, owing to the thermosetting gelation, promotes the bioadhesion of the system.

Even in this case the transition temperature from the sol condition to the gel is reversible (fig. 2).

Object of the present invention are pharmaceutical compositions useful for the transmucousal administration, in particular vaginal or nasal, of proteinic or peptidic substances pharmacologically active. Examples of similar substances include calcitonin, insulin, desmopressine, interleukin, interferon, GMCSF (granulocite monocite colony

stimulating factor), ciclosporin, posatirelin, protirelin, timopentin, pidotimod, mono or polyclonales antigenes, antigenic proteins of bacterial or viral origin, parathormon, gonadorelin, coagulation factors, epidermic growth factors, "insulin like" growth factor, endorphin and their derivatives or fragments, tioxoprolylcysteine, tioxoprolylthiazolidincarboxylic acid, irudine and their derivatives.

The pharmaceutical compositions, in accordance to the invention, can be in any form suitable for vaginal or nasal administration, such as soft gelatine vaginal capsules, vaginal suppository composed of natural or semi-synthetic glycerides, creams, gels, emulsions, suspensions, solutions, foams.

The liposomic systems can contain:

- modulators of transition temperature of phospholipids, such as cholesterol and its derivatives;
- antioxidant agents such as tochopherols, and their esters, BHA, BHT, carotenes;
- stabilizer agents;
- preservatives;
- an alcoholic solvent phase;
- eventual auxiliary substances, such as pH correctors, moisturizers, perfumes, essences.

The microemulsion systems, in addition to the components already mentioned and to the polyoxyethylene-polyoxypropylene copolymer, could

Obviously, the administration of liposomic and microemulsionated systems will be made easier by the use of suitable spray dispensers or applicators in form of cannula, syringe or similar devices.

According to a preferred embodiment of the invention, the compositions will contain stabilizer or absorption promoter, polygalacturonic acid, polyglucuronic acid, hyaluronic acid, hyaluronamine, hyaluronamide or their salts and pharmaceutical acceptable derivatives.

In vivo experimental studies employing products relevant to the invention, have shown that intravaginal or nasal route allow a systemic bioavailability comparable with that ones achievable by a parenteral administration, without presenting the limits of this route. As a consequence the dosage potency of proteins or peptidic substances farmacologically active by vaginal or nasal administration will be substantially similar to those already used for the well-known administration routes. It is possible that, using pharmaceutical forms not exactly metered, such as solutions, creams or gel, according to the invention, it is possible to obtain a personalization of the dosage: considering the often high pharmacological activity of the protein substances, this gives important advantages related to the reduction of the risks of overdose.

According to a preferred embodiment, the invention gives pharmaceutical compositions suitable to the vaginal or nasal administration containing as active ingredient a calcitonin of any source.

The high bioavailability level achievable by the vaginal administration of a calcitonin products relevant to the invention, with a proper bioadhesion, is shown by a pharmacological experiment. The decrease of calcemic level in rabbit serum after vaginal application of: a) a simple solution, b) a thermosetting gel and c) a thermosetting gel furtherly thickned with hyaluronic acid, has been measured. As a reference the decrease of calcemic serum level obtained by administration of an equal dose of the same drug by i.m. route (see tab. 1) was chosen.

Table 1

ADMINISTRATION		CALCEMIC LEVEL VS BASAL VALUE	
TYPE	ROUTE	AREA (cm^2)	% VS I.M.
Solution 100 I.U.	i.m.	444	100
Solution 100 I.U.	vaginal	264	60
Gel(Pluronic F127) 100 I.U.	vaginal	439	99
Gel(High m.w. Hyalur.Acid)100 I.U.	vaginal	425	95

The demonstration of a systemic absorption of proteic substances, when administrated by vaginal or nasal route employing liposomic or microemulsions bioadhesive preparations, make possible a vaccine-therapy uninvasive or other forms of immunitary protection using antigen substances.

It is well-known that the oral administration of

known too that a simple pharmaceutical oral dosage form cannot be employed with peptides or proteins. The object of the present invention is a pathway to bypass the limits of the oral route keeping a good compliance of the patients.

Neverthless the thermosetting liposomes or microemulsions not only are a drug delivery system particularly usefull for peptides and proteins, but can be advantageously employed also for low molecular weight drug, like nicotine, FANS and so on.

The invention will have a more detailed description by the following examples.

Example 1

Lecithin (4 g), and cholesterol (0.75 g) were dissolved in ethyl alcohol. Tocopherol acetate (0.02 g) was added to the solution. In an other container, sodium methylparaben (0.15 g), edetate disodium (0.1 g) and salmon calcitonin (7 mg) were dissolved in purified water (80 mL). The aqueous solution was added to the first one under stirring. The alcohol was evaporated by heating to form a liposomic dispersion . Thereto were added Lutrol F127 (13 g) and purified water (q.s.to reach 100 mL). The liposomic dispersion was subdivided in glass vials that following were closed with a minipump. A pre-arranged unit dose administration was so allowed.

Example 2

Soybean lecithin (30 g), tocopherol acetate (500 mg) and cholesterol (2 g) were dissolved by heating in isopropyl alcohol. The solution was keeped at 50°C until 50 mM citrate buffer (pH 4.5, 1000 mL) containing

calcitonin (50 I.U./mL), beforehand heated at the same temperature, was added, to give a hydro-alcoholic phospholipid dispersion. The mixture was vigorously shaken under reduced pressure causing the evaporation of isopropyl alcohol and giving a liposomic dispersion of calcitonin. Hydroxyethylcellulose (10 g) was added and a gel, having a suitable viscosity for the vaginal application, was obtained.

Example 3

Hyaluronic acid sodium salt (10 g) and Posatirelin (3.33 g) were dissolved in 50 mM citrate buffer (pH 4.5, 1000 mL). A suitable amount of Pluronic F127 was added, so to obtain an increased viscosity to body temperature. The gel formed shows a good clearless and can be applied into the vagina syringe dispenser.

Example 4

Lecithin (6 g) was dissolved in a mixture of isopropyl myristate and ethyl alcohol (12.5 mL). After complete dissolution tocopherol acetate (0.02 g) was added. Thereto sodium cholate (4 g) was suspended. Into an other container sodium methylparaben (0.15 g) and calcitonin (7 mg) were dissolved in purified water (60 mL). Aqueous solution of calcitonin was added to lipophylic phase, maintained vigorously shaked. To the formed microemulsion, Pluronic F127 (15 g) was added and dissolved. A necessary amount of purified water to make the entire amount 100 mL was added. The microemulsion was optically clearless and shown a transition temperature sol-gel of about 30-40°C.

Example 5

(0.225 g) and salmon calcitonin (12 mg) were dissolved in purified water (100 mL). A solution, obtained dissolving lecithin (5.6 g), cholesterol (1.12 g) and tocopherol in slightest amount needed of ethyl alcohol, was added. Thereto polyoxyethylene-polyoxypropylene copolymer (Pluronic F127, 19.5 g) was dissolved, and a necessary amount of purified water to make the entire amount 150 mL was added. The liposomic dispersion was subdivided into aerosol pressurizated container giving a thermosetting liposomic foam.

Example 6

Lecithin (30 g) and nicotine (3.8 g) were dissolved in a mixture of isopropylmiristate and ethyl alcohol, keeping at 50°C until dissolution. After complete dissolution tocopherol acetate (0.6 g) was added and sodium cholate (15 g) was suspended. Into an other container sodium methylparaben (0.5 g) and sodium edetate (0.5 g) were dissolved in pre-heated (60°C) purified water (300 mL). Aqueous solution was added to lipophilic phase, maintained vigorously shaked. The formed microemulsion was cooled to 5-10°C then Pluronic F127 (75 g) was added and dissolved. A necessary amount of purified water to make the entire amount 500 mL was added. The microemulsion, that shown a transition temperature sol-gel of about 30-40°C, can be applied on the skin or on the nasal mucousal with a suitable device.

CLAIMS

1. Pharmaceutical compositions suitable to drug protein or peptide administration on body mucosal surface characterized in that they are composed by:

a) a multiphasic pharmaceutical administration system containing the active drug substance;

b) a thermosetting polymer or copolymer able to enhance the viscosity of the system after the exposition to the body temperature;

2. Pharmaceutical compositions as described in the claim 1, characterized in that the multiphasic pharmaceutical administration system is represented by a liposomic suspension or dispersion.

3. Pharmaceutical composition as described in the claim 1, characterized in that the multiphasic pharmaceutical administration system is represented by a microemulsion or other pluriphase system containing at least a dispersed oily phase and a continuous aqueous phase or a dispersed aqueous phase and a continuous oily phase.

4. Pharmaceutical compositions as defined in the preceeding claims, characterized in that these are suitable to promote protein or peptide drugs absorption through the skin or mucousal membranes.

5. Pharmaceutical compositions as defined in the preceeding claims, characterized in that these are suitable to promote protein or peptide drugs absorption through the vaginal mucousal tissue.

suitable to promote protein or peptide drugs absorption through the nasal mucousal tissue.

7. Pharmaceutical compositions as defined in the preceeding claims, characterized in that these are suitable to promote protein or peptide drugs absorption through the rectal mucousal tissue.

8. Pharmaceutical compositions as specified in the preceeding claims, characterized by the presence of polyoxyethylene-polyoxypropylene copolymers as thermo-setting agents (able to increase the product viscosity by mean of the sol-gel phase transition induced by the exposition to the temperature of the body administration site).

9. Pharmaceutical compositions according to claim 8, where the thermosetting agent is represented by a copolymer known with the trade name of PLURONIC F127™, in a final concentration range between 10% and 30% w/w, preferentially between 13% and 20% w/w.

10. Pharmaceutical composition according to the preceeding claims, containing a protein or peptide drug selected from the group consisting of calcitonin, insulin, desmopressine, interleukin, interferon, GMCSF (granulocite monocite colony stimulating factor), ciclosporin, posatirelin, protirelin, timopentin, mono or polyclonal antigens, bacterial or viral antigenic protein, parathormon, gonadorelin, coagulation factors, epidermic growth factors, "insuline like" growth factor, endorphin and derivatives or fragment, thioxoprolylcysteine, tioxoprolilthiazolidincarboxylic acid, nicotine, irudine and/or their derivatives.

11. Pharmaceutical compositions according to the

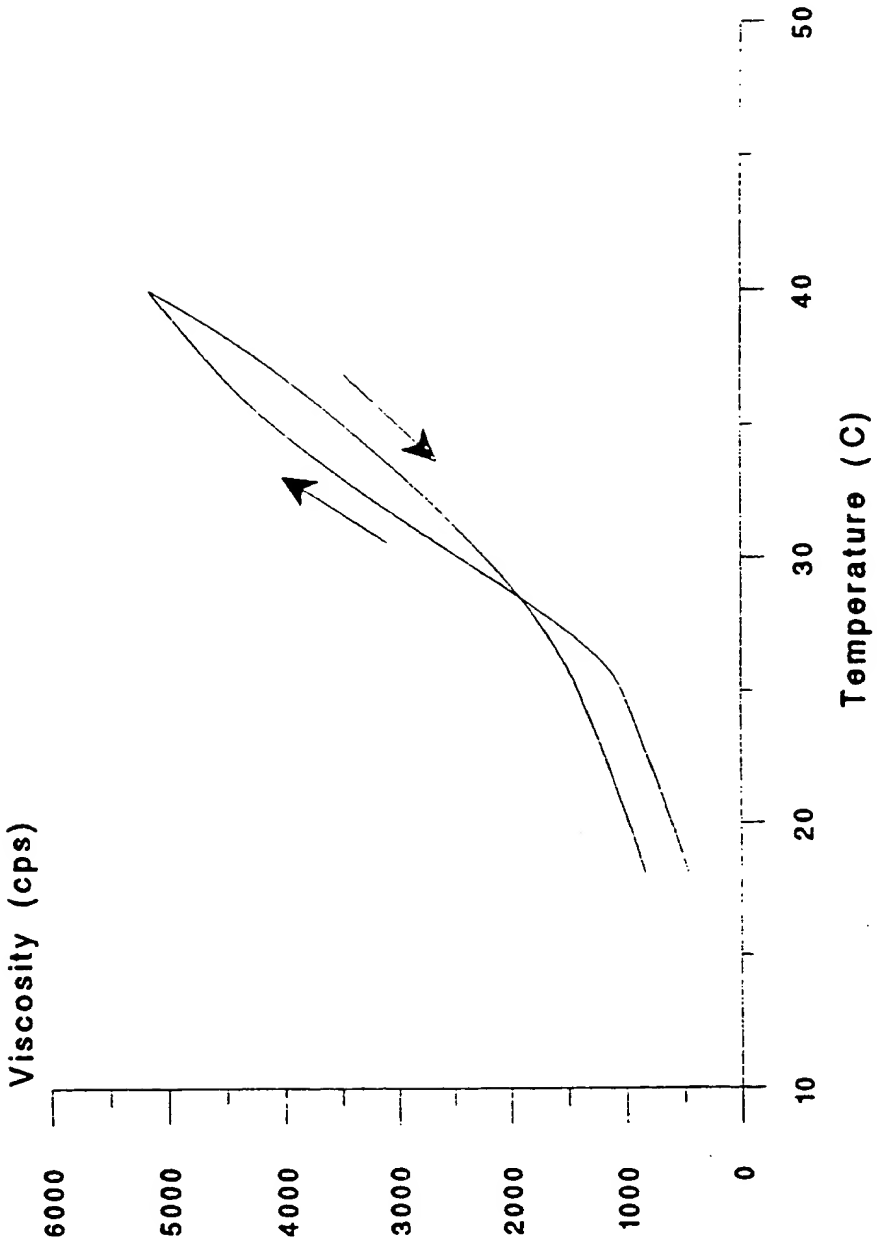
preceeding claims, where the protein or peptide drug is represented by a calcitonin.

12. Pharmaceutical composition according to the preceeding claims, where the drug is represented by an antigen or an antibody suitable to be used for immunotherapy.

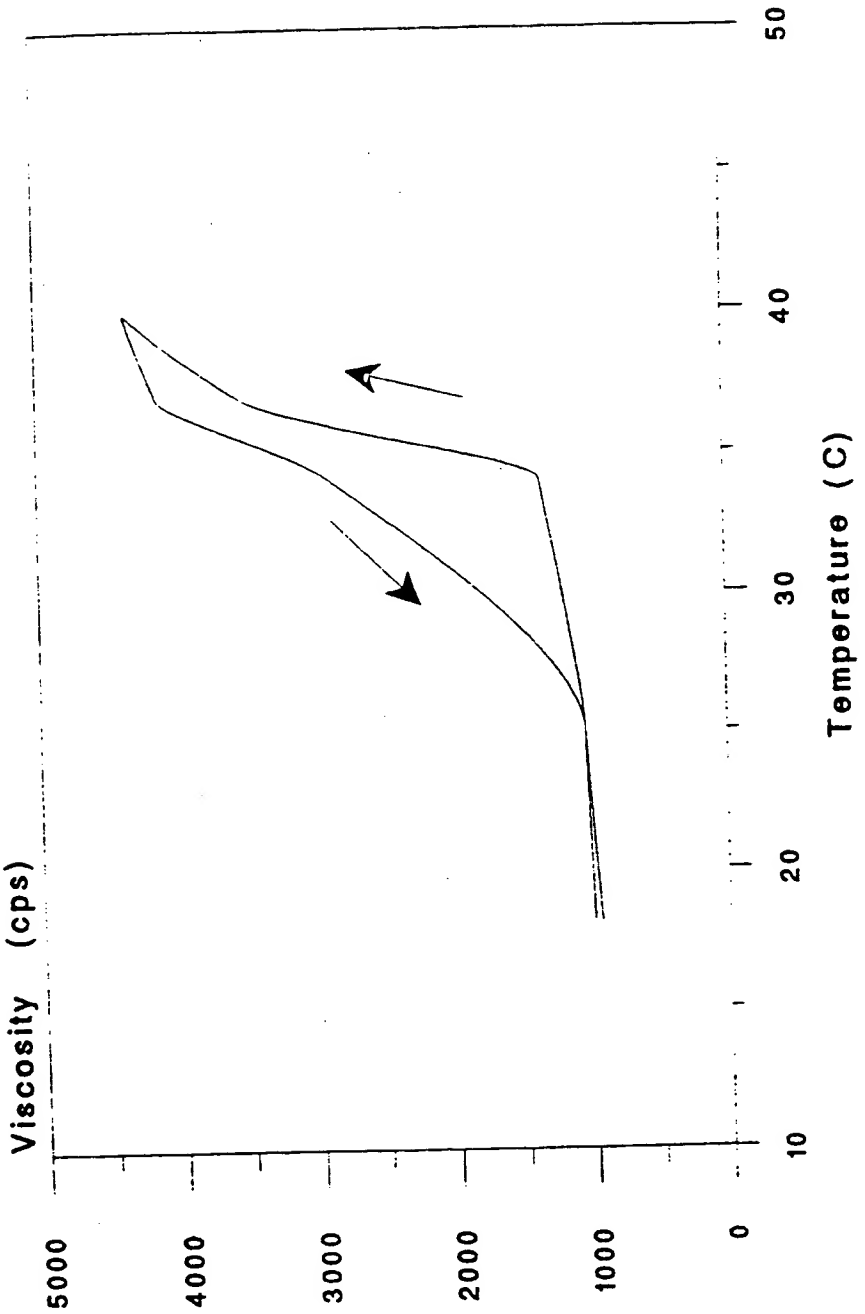
13. Pharmaceutical compositions according to the preceeding claims, containing as absorption enhancers or stabilizers one or more of the biopolymers polygalacturonic acid, polyglycuronic acid, hyaluronic acid, hyaluronamide or their salts or derivatives.

14. Pharmaceutical compositions according to the preceeding claims able to be administered as dermal or vaginal foam.

THERMOSETTING LIPOSOMES - Figure 1



THERMOSETTING MICROEMULSIONS - Figure 2



INTERNATIONAL SEARCH REPORT

Inte. ional Application No
PCT/EP 93/01965

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A61K9/127 A61K9/107 A61K9/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
-

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,90 00048 (TEMPLE UNIVERSITY OF THE COMMONWEALTH SYSTEM OF HIGHER EDUCATION) 11 January 1990 see page 1, line 17 - line 26 see page 3, line 9 - line 10 see page 5, line 15 - line 25 see page 8, line 25 - page 9, line 29 see page 12 - page 14; example 1	1
Y	EP,A,0 386 960 (AMERICAN CYANAMID COMPANY) 12 September 1990 see page 1, line 1 - page 5, line 35 see page 7, line 36 - page 8, line 20	1-14
Y	US,A,4 944 948 (USTER ET AL) 31 July 1990 see the whole document	1,2,4-14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 January 1994	14. 01. 94

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	FR,A,2 660 192 (POLI INDUSTRIA CHIMICA S.P.A.) 4 October 1991 see page 8 - page 9; example 8	1,2

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter Application No
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